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Simulation of Ion Beam Injection and Extraction in an EBIS*

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To simulate Electron-Beam Based Ion Sources (EBIS), FAR-TECH has developed an integrated toolset [1] consisting of: PBGUNS, which calculates steady-state electron beam from cathode to electron collector and ion beam injection and extraction in complicate beam line structures; and EBIS-2D, which is a time-dependent, self-consistent particle-in-cell code that tracks both the injected primary ions and the ions from the background neutral gas in the trap region of an EBIS.

We will present an example simulation of Au+ charge breeding experiment at BNL RHIC EBIS [2]. In the experiment, the injected Au+ ion beam current was 1mA. In the simulations, the trajectories of injected ions from the injection deflector to the collector entrance are calculated with PBGUNS self-consistently by including the space charges from both ions and electrons. From the collector entrance to the ion trap, the ion beam, starting with initial conditions within the 100% acceptance of the electron beam, is tracked by EBIS-2D until 200 microseconds after the trap barrier is closed. In the trap, the evolution of the ion charge state distribution (CSD) is estimated by CHASER (0D charge state estimator). The extraction of charge bred ions is simulated with PBGUNS. The simulations of the ion injections with different ion beam currents show significant ion space charge effects on beam capture efficiency and the ionization efficiency. The simulated CSD is in good agreement with experimental measurements when the electron beam neutralization effects are included in the 0D model.

[1] J. S. Kim, L. Zhao, J. A. Spencer and E. G. Evstatiev, "Electron-beam-ion-source (EBIS) modeling progress at FAR-TECH, Inc. ", AIP Conf. Proc. **1640**, 44 (2015)
[2] E. Beebe, J. Alessi, S. Binello, T. Kanesue, D. McCafferty, J. Morris, M. Okamura, A. Pikin, J. Ritter and R. Schoepfer, "Reliable operation of the Brookhaven EBIS for highly charged ion production for RHIC and NSRL", AIP Conf. Proc. **1640**, 5 (2015)

* The work is supported by the DOE SBIR program with the Office of Nuclear Physics.